

2009 - 2010 TRAC-Suspension Bridge Competition Rules

Grades 11 and 12 (Rev. 11-3-09)

The **TR**ansportation and **C**ivil Engineering (TRAC) Program

THE PURPOSE OF TRAC: The TRAC program is a new and inventive way of introducing students to the wide variety of career opportunities available in the field of engineering. The program teaches students how to apply math and science concepts to common engineering problems occurring in transportation systems. The TRAC program also is designed to allow students to identify and evaluate the social and environmental impacts associated with the development of new transportation systems within their communities.

COMPETITION FOR 11th AND 12th GRADES

The Competition:

The Suspension Bridge competition is designed to be an extended activity created from the TRAC PAC 2 Bridge Builder module. This event is designed to allow students the opportunity to develop a suspension bridge that will be tested to determine if specification measurements were met and for strength-to-weight ratio. Student teams will be competing against other TRAC student teams throughout Michigan. Interested teams should fill out the [application](#) and submit it prior to the deadline of **Nov. 30, 2009**.

Upon receipt of the completed application postmarked on or before **Nov. 30, 2009**, the Michigan Department of Transportation (MDOT) will send an informational packet and kit to each team. Only materials included in the kit can be used in the construction of the bridge. The kit will be shipped by **Dec. 11, 2009** and will include the following:

- ☐ Popsicle Sticks
- ☐ Balsa Wood
- ☐ Wood Glue
- ☐ String (two different weight/gauge)
- ☐ Power Draft CAD Software by Bentley Systems, Inc. The software is available for download at www.michigan.gov/mdot-trac. **All CAD drawings must be completed using this software.**
- ☐ Informational Packet

Each team is required to submit two copies of their COMPLETE proposal to the MDOT TRAC Program. Do not send the bridge itself. The proposals must be postmarked no later than **March 5, 2010**. All entries become the property of MDOT and will not be returned.

The proposals will be reviewed for completeness by the MDOT Bridge Challenge Committee. Please review the “Proposal Requirements” section on page 7 of this document. Teams will be notified whether their proposal was accepted as complete by March 11, 2010. Teams who submitted complete proposals will be invited to compete at the Michigan Design and Build Bridge Challenge to be held in East Lansing on April 12, 2010. Teams must have a complete constructed bridge, using the suspension bridge that was designed in their proposal, and a PowerPoint presentation (seven to 10 minutes in length) to compete against other Michigan teams to determine the winning suspension bridge. If a team attends the competition and does not have both a PowerPoint presentation and a complete constructed bridge, that team will not be reimbursed for contest expenses.

Who Can Enter:

- ☐ Only schools involved in the Michigan TRAC program can enter the competition.
- ☐ Students must be in 11th and 12th grades.
- ☐ Teams must be composed of three members - no less, no more. Team member changes will be allowed up until **March 1, 2010**. Each student can be a member of only one team.

The Problem:

The goal of this competition is to develop a suspension bridge that will carry as much weight as possible, yet weigh as little as possible while meeting all of the measurement specifications listed in the rules.

Each team is to design and construct a suspension bridge made only with the materials provided in the TRAC Challenge Entry Kit. Each suspension bridge will be tested for its strength-to-weight ratio and how well it meets the design specifications according to the rules. The bridges will be weighed at the competition to calculate strength-to-weight ratio.

Entries will be judged on a PowerPoint presentation, measurement specifications, and strength-to-weight ratio values. As a part of the Design Competition, each team is required to develop a proposal describing the design, testing and operation of the suspension bridge.

The Challenge:

Design and build a suspension bridge that meets specification requirements and has the greatest strength to weight ratio. Strength-to-weight ratio is determined by dividing maximum load by weight of bridge.

Example:

Maximum load = 120.0 pounds

Bridge weight = 20.0 grams

Ratio = 2,724.0

$[(120.0 \text{ pounds} \times 454 \text{ grams per pound}) / 20.0 \text{ grams}]$

Specifications:

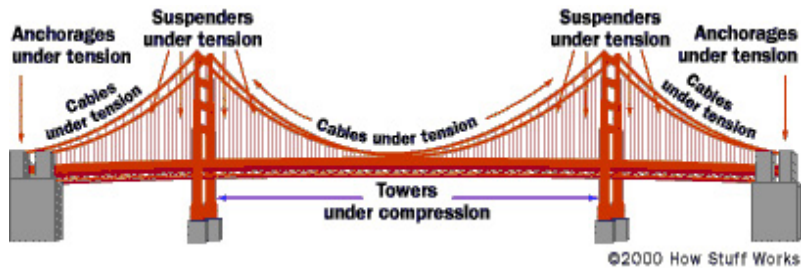
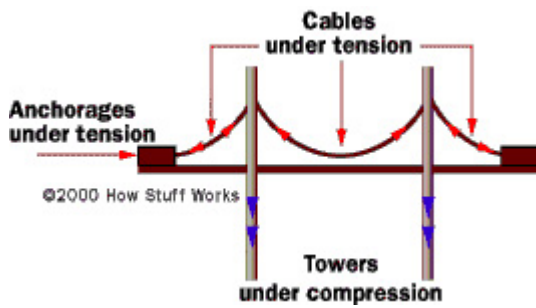
- ☐ The balsa wood used to construct each suspension bridge must be only *ONE LAYER* thick. At the joints, the balsa wood bridge may need to be more than one layer thick. These joints may not be any more than 1/8-inch thick. The length of the double layer at the joint may not exceed 1 inch in length.
- ☐ Lamination is not permitted.
- ☐ The materials provided are the **ONLY** materials to be used to build the bridges. The use of additional material is permitted for decorations or visual aids.
- ☐ A car that is 2 inches wide and 1 inch tall must be able to drive across the bridge while the bridge is closed.
- ☐ The bridge will be tested for strength-to-weight ratio.
- ☐ The bridge must have no more than two anchorages on each end.
- ☐ The bridge can have no more than and no less than two towers.
- ☐ The towers can be up to 8 inches tall as measured from the roadway bed to the top of the tower. The bottom of the towers will sit on the bottom of the Pitsco Bridge Tester between the vertical supports of the tester. See the dimensions of the Pitsco di2000 Structure Tester.
- ☐ The main cables strung from one tower to the other tower (the cable that forms the U-shape in the example picture on page 4) can come no closer than two inches from the roadway bed at the lowest point of the each main cable.
- ☐ The total length of the bridge must be 15 inches.
- ☐ The bridge must have supports and anchorages suitable for placement on Pitsco di2000. Please see picture of Pitsco tester on page 5.

StructureTester (<http://catalog.pitsco.com/store/detail.aspx?ID=2557&bhcp=1>). For additional information on the tester, visit www.pitsco.com.

- ☐ The clear span (i.e., open area with no physical obstructions) between the towers must be a minimum of 10 inches and a maximum of 11.5 inches apart.
- ☐ The center of the bridge must be open to make it possible for the rod of the Pitsco di2000 Structure Tester to fit.
- ☐ The vertical supports of the Pitsco di2000 will be placed 13 inches apart on center.
- ☐ No part of the suspension bridge can make contact with any part of the Pitsco di2000 Bridge Tester that is located between the vertical supports of the Pitsco di2000.

The bridge must meet the above dimensions or points will be deducted. Testing of the bridge can not be hindered in anyway. The testing block must fit onto the bridge without obstructions. At the time of testing, if the bridge does not fit on the Pitsco di2000, the bridge will be disqualified.

Example for 11th and 12th Grade Suspension Bridge Competition



The towers will fit down into the tester.



Pitsco di2000

PREPARING FOR COMPETITION

Form a team of interested students or friends. Discuss the challenges and design specifications. Teams are limited to only three students. Each team must have at least one teacher or other adult to help and advise, though a single adult may be advisor to more than one team.

Study the rules. The individual challenge documents and the grading criteria will give important information, which must be followed if your team is to achieve the best results. Failure to adhere to the rules could lead to penalties, or even disqualification. If any of the information is not clear, please call for additional help.

Plan the timing of the project. Ensure that everyone in the team knows the date for submission of the written proposal and recognizes that this means all major development work should be finished before this date.

Keep records of meetings and working drawings carefully, and give members of the team responsibility for different sections of the final proposal.

Notes to Adults: MDOT would like to stress that **the work on all phases of the project is to be done by the students.** Adult assistance is to be limited to:

- ☐ Mentoring
- ☐ Basic guidance of the students
- ☐ Teaching engineering, mathematical and scientific principles applicable to the project
- ☐ Guiding students in research
- ☐ Assisting in the production of the proposal and preparation of the drawings
- ☐ Overseeing the manufacturing stages of the project

Guidance should be in the form of asking questions (leading questions, if necessary) to promote creative thinking by the students to identify the scientific and engineering principles involved. ***Encourage students to consult library books and other resources*** to help with the project. ***Encourage students to test and improve their designs***. A good way to begin is for each student to design and/or construct a rough prototype. The team as a whole can then develop the most successful design and construction techniques. Further testing and improvement should continue throughout the project.

Scoring:

The information below gives an indication of what the judges are looking for in each section. Students should be aware that to receive the maximum number of points, they need to fulfill all the criteria for each section.

I. PROPOSAL

Criteria:

- ***Content and organization*** (make sure your proposal contains all the sections outlined on page 7)
- ***Style and presentation*** (form, format, mechanics, and visuals)
- ***Timeliness*** (proposals received after the deadline will not be accepted)

II. DESIGN AND CONSTRUCTION

Judges will examine each entry to make sure it fits the specifications given in the “Specification” portion of this document (read this carefully). Points will be deducted if specifications are not met. At the time of testing, if the bridge does not fit on the Pitsco di2000, the bridge will be disqualified.

III. ORAL PRESENTATION

Criteria:

- ***Explanation of Project: seven to 10 minutes (points will be deducted if time is less than seven minutes or exceeds 10 minutes). A rubric has been provided for the presentation as a guide. (See page 10)***

IV. PERFORMANCE

Criteria:

Construct a bridge having a maximum strength-to-weight ratio. The bridge must be constructed in a manner that meets all specification requirements listed in this document.

PROPOSAL REQUIREMENTS

Format Requirements:

- I. Typed**
- II. Double-spaced**
- III. 12-point font (Arial or Times New Roman)**
- IV. All pages on 8.5 by 11-inch paper**
- V. Information in proper order (listed below)**
- VI. All pages numbered**

Proposal Components:

- I. Title Page.** Include name of challenge, team name and logo, name of school or organization, names of students, and name of teacher or advisor.
- II. Table of Contents.**
- III. Summary (abstract).** Clearly and concisely stated. (No more than two pages)
- IV. Introduction.** Indicate the team name as well as the background of each member, information about the school, and community.
- V. Body.** The main part of the report. This may be divided into several sections (such as design, development, etc.). In general, this part should:
 - a. Identify all sections.
 - b. Explain the reasons behind your design.
 - c. Explain why you designed your entry the way you did.
 - d. Explain the scientific principles behind your design.
 - e. Include data tables, graphic representation of tests, and supporting calculations page.
 - f. Include scaled drawings of suspension bridge using Power Draft CAD Software by Bentley Systems, Inc.
 - g. Explain how you tested your design, and the improvements this led you to make.
 - h. Describe the problems that you encountered in designing and building your product and how you solved these problems.
 - i. Describe any safety features that were considered and/or used.
- VI. Conclusions (and Recommendations).**
 - a. How successful is your project?
 - b. What did you learn by taking part in the bridge challenge?
 - c. Recommendations.
- VII. Acknowledgments.**
 - a. List the names of the adults who assisted you in the project.
 - b. Provide a brief description of what the adults did.

- c. Include a certification, signed by all student team members and adults assisting, stating that: “We hereby certify that the majority of the ideas, design, and work was originated and performed by the students, with limited assistance by adults, as described above.”

VIII. Bibliography. List all references used, including Internet, books and magazines.

IX. Appendices. Should be introduced, integrated and discussed in the body text. They should include:

- a. **Safety.** List the general safety procedures that were followed to make sure that no one got hurt.
- b. **Team members.** List the team members, with a short description of how each person helped to make the project a success. What special skills were learned or demonstrated? What were the specific skills of each team member?
- c. **Scheduling and Accomplishments.** *Briefly* show on a timeline, or similar method, how you scheduled your project. Include records of meetings, telling how you managed the schedule.
- d. **Records of Meetings and Management of Schedule.** Include any meeting minutes or information on how meetings were managed.
- e. **Daily Journal.** Progress reports of day-to-day work on the project, including date, performance and comments from each team member.
- f. **Tools and Machines.** List and describe any special tools or machines that were used.
- g. **Working Drawings.** Include working drawings not contained in the design section.

JUDGING

Judges: Executive-level Civil Engineers will be judging the challenge.

Awards: Teams invited to the Michigan Statewide Design and Build Bridge Challenge will be competing for the following prizes.

First-Place Team: \$600

Second-Place Team: \$375

Third-Place Team: \$225

SCHEDULE

- Applications due **Nov. 30, 2009**.
- Kits will be shipped to teams by **Dec. 11, 2009**.

MDOT Challenge Entry Kits will include:

- ☐ Popsicle Sticks
- ☐ Balsa Wood
- ☐ Wood Glue
- ☐ String (two different weight/gauge)
- ☐ Informational Packet

Power Draft CAD Software by Bentley Systems, Inc. is available for download at www.michigan.gov/mdot-trac. All CAD drawings must use this software.

- Proposals are due **March 5, 2010** (do not include the suspension bridge).
- Notification of complete proposals by **March 11, 2010**.
- Shirts will be distributed to the successful teams at the Registration desk on **April 11 and 12, 2010**.
- Design and Build Bridge Challenge, April 12, 2010, at the Kellogg Hotel and Conference Center in East Lansing.

Any questions, please contact:

Jan Pohl
Michigan TRAC Program Manager
P.O. Box 30050
Lansing, MI 48909
pohlj@michigan.gov
517-373-9571

Michigan Bridge Challenge
11th and 12th Grade – Suspension Bridge Competition
Oral PowerPoint Presentation Scoring Rubric

CATEGORY	5	4	3	2	1
Content	Covers topic in-depth with details and examples. Subject knowledge is excellent.	Includes essential knowledge about the topic. Subject knowledge appears to be good.	Includes essential information about the topic but there are one to two factual errors.	Content is minimal OR there are several factual errors.	Did not fulfill assignment requirements.
Mechanics	No misspellings or grammatical errors.	Three or fewer misspellings and/or mechanical errors.	Four misspellings and/or grammatical errors.	More than four errors in spelling or grammar.	Did not fulfill assignment requirements.
Organization	Content is well organized using headings or bulleted lists to group related material.	Uses headings or bulleted lists to organize, but the overall organization of topics appears flawed.	Content is logically organized for the most part.	There was no clear or logical organizational structure, just lots of facts.	Did not fulfill assignment requirements.
Oral Presentation	Interesting, well-rehearsed with smooth delivery that holds audience attention.	Relatively interesting, rehearsed with a fairly smooth delivery that usually holds audience attention.	Delivery not smooth, but able to hold audience attention most of the time.	Delivery not smooth and audience attention lost.	Did not fulfill assignment requirements.
Attractiveness	Makes excellent use of font, color, graphics, effects, etc., to enhance the presentation.	Makes good use of font, color, graphics, effects, etc., to enhance presentation.	Makes use of font, color, graphics, effects, etc., but these detract from the presentation content.	Use of font, color, graphics, effects, etc., but these often distract from the presentation content.	Did not fulfill assignment requirements.
Timeliness	Seven to 10 minutes.	One point off for up to one minute under/over.	Two points off for up to two minutes under/over.	Three points off for up to three minutes under/over.	Four points off for up to Four or more minutes under/over.

NOTE: This is a rubric to help with the preparation of the presentation. Oral presentation will count 25 percent of the total team score for the competition. This rubric will also be used by the judges to score the presentations. The remaining 75 percent of the team score will be determined by the outcome of the specification measurements and strength-to-weight ratio calculations.